# Analysis of Object Oriented Metrics Collected by the SATC from NASA Projects in 1998

The table below summarizes the Object Oriented metrics that were collected by the SATC during FY 1998.  Of the nearly 20,000 classes analyzed, the vast majority (93%) were written in the C++ language.  It is expected that the proportion of Java classes written for NASA systems will increase during the next year.

| Summary of  OO Project Metrics | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| *Project ID* | *# Files* | *# Classes* | *# NTLC* | *LOC* | *PreProcess* | *Blank* | *Comm.* | *CP* | *NCNB* | *Exec. Stmts.* | *ExCC* | *Lang.* |
| | | | | | | | | | | | | |
| C100a | 322 | 140 | 81 | 57,086 | 3,620 | 12,250 | 17,664 | 39% | 29,014 | 14,037 | 3,504 | C++ |
| C100b | 481 | 201 | 124 | 92,231 | 6,449 | 20,019 | 28,058 | 39% | 47,770 | 23,002 | 4,667 | C++ |
| C100c | 735 | 355 | 204 | 167,541 | 11,264 | 34,612 | 49,940 | 38% | 89,743 | 42,756 | 8,679 | C++ |
| C100d | 1,193 | 562 | 297 | 261,260 | 20,932 | 50,862 | 78,104 | 37% | 145,648 | 64,935 | 13,376 | C++ |
| C101 | 3,227 | 1,966 | 611 | 838,128 | 43,552 | 108,335 | 290,628 | 40% | 443,824 | 175,736 | 43,999 | C++ |
| C102a | 6,735 | 5,107 | 2,297 | 2,062,982 | 80,193 | 469,213 | 523,035 | 33% | 1,102,727 | 506,790 | 95,889 | C++ |
| C102b | 7,292 | 5,035 | 2,294 | 2,129,555 | 89,532 | 483,859 | 542,214 | 33% | 1,137,418 | 513,001 | 97,087 | C++ |
| C102c | 5,975 | 4,566 | 2,095 | 1,948,354 | 79,184 | 434,469 | 485,953 | 32% | 1,058,117 | 481,954 | 86,221 | C++ |
| C++ totals | 25,960 | 17,932 | 8,003 | 7,557,137 | 334,726 | 1,613,619 | 2,015,596 | 3 | 4,054,261 | 1,822,211 | 353,422 | |
| J100a | 210 | 222 | 81 | 64,492 | 775 | 15,693 | 14,768 | 30% | 34,468 | 18,756 | 5,499 | JAVA |
| J100b | 229 | 243 | 88 | 70,514 | 850 | 16,771 | 16,224 | 30% | 37,980 | 20,403 | 6,055 | JAVA |
| J100c | 325 | 349 | 132 | 113,919 | 1,087 | 24,558 | 27,434 | 31% | 62,795 | 30,736 | 10,381 | JAVA |
| J100d | 516 | 565 | 185 | 177,356 | 1,727 | 35,516 | 45,032 | 32% | 98,300 | 47,191 | 16,158 | JAVA |
| Java Totals | 1,280 | 1,379 | 486 | 426,281 | 4,439 | 92,538 | 103,458 | 1 | 233,543 | 117,086 | 38,093 | |

## Number of Methods per class
The first two charts in the attached set reveal that very few OO classes had more than 50 methods, whether the code was in C++ or java.  Based on this data, the SATC recommends that classes with more than 20 methods are marginal for risk, and classes with more than 40 methods are extremely complex and high risk.

## Coupling Between Objects
The next two charts confirm the SATC's position that NASA OO code seldom has CBO values greater than 10, and CBO < 5 is the norm.

## Response for class
The two bar charts for Response for Class reveal a significant difference between C++ and Java classes.  Due to the design and nature of the Java language, RFC values tend to be higher than those written in C++.  Current research is focused on establishing reasonable guidelines for maximum RFC for each language.

## Weighted Methods per Class
Most NASA OO classes, whether C++ or Java, have WMC values below 100, which is the current SATC recommended maximum. Java code appears to tend toward greater values of WMC than C++.

## RFC versus NOM
SATC is currently recommending that RFC should not exceed 5 times the number of methods in a class.  Given that this has been the case for 96% of NASA C++ classes analyzed, this is a reasonable guideline.  However, as the database for Java code continues to grow, it appears that Java classes will often exceed that value for RFC, and a separate guideline will be appropriate.